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ABSTRACT

Five experiments are reported which relate to sex-role identification in problem solving. Instruments used on high school and college students include a booklet of 20 problems that had illustrated sex differences during an earlier study, the Terman-Miles M-F Test to measure sex-role identification, an open-ended personal history questionnaire and an oral mucosal smear to determine genetic sexuality. Sex differences in problem solving were clear. When the characteristics of the problems were altered to make them less appropriate to the masculine and feminine sex-roles, sex differences in problem solving were reduced. Masculine role identity was associated with a choice of analytic approach, feminine role identity with seeking help. Women indicate more frequently that they would use trial and error. The mean number of problems solved by men exceeded the number solved by women in the limited time. Problem form (abstract or manipulative) did not show significant influence by sex. (KS)

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FIVE STUDIES
OF THE RELATION BETWEEN SEX-ROLE IDENTIFICATION AND ACHIEVEMENT IN PROBLEM SOLVING

by

G. Alexander Milton

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FOREWORD

The collection of much and the analysis of all of the data in the studies reported here was carried out under Project NR 150-166 and supported by Contract Nonr 609(20) between Yale University and the Office of Naval Research. Appreciation for their work in connection with the contract is extended to Dr. D. D. Smith, Head, Psychological Sciences Division, and to Dr. John Nagay, Assistant Head, Personnel and Training Branch.

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A word of explanation may be appropriate concerning the fact that although this report and Technical Report No. 4 under this same contract deal with related problems, neither makes reference to the other. The preparation of these two reports occurred simultaneously during a period when the author of one was in residence at the University of Colorado and the author of the other was in residence at Yale. In order not to delay the appearance of either report, it seemed desirable to postpone to a later report the discussion of the interrelations of the findings. Indeed, more work may be needed before the interrelations can be fully understood.

Donald W. Taylor
Professor of Personnel Administration
and of Psychology

ACKNOWLEDGEMENTS

The experiments contained in this technical report are all oriented about a common topic, the relation of sex-role identification to problem solving. The original stimulus for this series of studies can be found in experiments on thinking done in the Department of Psychology at Stanford University under Project NR 150-149, supported by Contract N6onr 25125 between Stanford University and the Office of Naval Research. The collection of much and the analysis of all of the data in the present studies was carried out under Project NR 150-166 and supported by Contract Nonr 609(20) between Yale University and the Office of Naval Research. Appreciation is expressed to Professor Donald W. Taylor, formerly principal investigator for the Stanford Project and now principal investigator for the Yale Project.

To Mr. James McIntosh of the Half Moon Bay High School, Half Moon Bay, California, must go thanks for his assistance in securing and running the subjects who participated in the first study reported here.

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Finally, appreciation for their help is due to Paul C. Berry and Clifford H. Block of the Yale Department of Psychology, to Mrs. Ruth S. Taylor, and to Dr. Olga McNemar of the Stanford Department of Psychology.

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ACHIEVEMENT IN PROBLEM SOLVING
AS RELATED TO SEX-ROLE IDENTIFICATION

The present study was designed primarily as a replication of an earlier one (Milton, 1957) in which results were obtained indicating that there is a positive relationship between masculine sex-role identification and problem-solving skill both across sexes and within a sex, and that when allowance is made for this relationship, the difference between men and women in problem-solving performance is diminished. Previously, Sweeney (1953) had demonstrated consistent sex differences in problem-solving performance even when differences in intellectual aptitude, academic training, and special abilities had been controlled.

The principal hypothesis of this study is that achievement in problem solving is positively correlated with the degree of identification with the masculine role. From this hypothesis two predictions are made: (a) This positive relationship exists within a sex as well as across sexes and sex-role identification contributes significantly to variance in problem-solving skill within a sex. (b) When an adjustment is made for the between-subjects variance contributed by sex-role identification, sex differences in problem-solving skill will not be significant.

In addition to testing the principal hypothesis, two additional areas of investigation were explored. First, since it had been suggested that the relationship between sex role and problem solving may be due to a joint hereditary biological determinant, an attempt was made to measure genetic sexuality and relate it both to problem-solving skill and to sex-role score. Secondly, an exploration was undertaken of factors in the personal history of the individual which might be jointly related to sex role and problem solving. The rationale for this exploration was that if the relationship between sex-role identification and problem-solving skill is an acquired one, significant factors in the life history of the subjects should emerge.

Method

The procedure and instruments used in this study replicate in large part the earlier study (Milton, 1957). The same 20 problems that had shown significant sex differences were employed. The problems were bound in a booklet with one problem per page so that each problem was presented individually. A working time of four minutes per problem was allowed with a ten-minute intermission after the first ten problems. Problems were scored either correct or incorrect with no partial credits given. The problem series is reproduced in Appendix 1.

The Terman-Miles M-F Test was used as the measure of sex-role identification (Terman and Miles, 1936). Personal history data was obtained from a one-page open-ended questionnaire on which subjects reported about their family history, past experience, aspirations, etc. This questionnaire can be found in Appendix 2.

Genetic sexuality was measured by means of the oral mucosal smear technique, a technique which has been found to produce a percentage distribution for each sex and to be almost non-overlapping between sexes (Herrmann and Davis, 1956; Greenblatt, de Acosta, Vasquez and Mullins, 1956). A scraping from the mucosal lining of the inside of the cheek was taken with a wooden tongue depressor from each subject. This sample was placed on a slide and the slide was placed in an ether-alcohol solution.

The slide was later stained and read. Reading the slides consisted of looking for a dark-stained particle on the nucleus of each cell. This particle or "blip" occurs more frequently in cells taken from female subjects than from male subjects. The score used in this study was the number of cells out of 100 cells from each subject which displayed the dark-stained particle.

Subjects. Seventy-nine high school students from the Half Moon Bay public high school participated as subjects in this experiment. Of these, 37 were females and 42 were males. The age range in the sample was 13 to 18 years. Scores on the Otis Quick-Scoring Test of Mental Ability were available for all subjects as an estimate of intelligence.

Procedure. The subjects were tested in five groups of eight to 26 subjects each, and the tests were conducted in two sessions. The problem-solving test was presented during the first session and the Terman-Miles M-F was administered during the second along with the biographical questionnaire and the collection of oral mucosal slides.

Results

The results of this experiment confirm the principal hypothesis rather nicely. As in previous studies, the basic difference between men and women on the problem solving task is obtained. The means are 4.38 for men and 2.31 for women, the difference being significant at the .05 level (Table 1). However, as also can be seen from Table 1, this difference is diminished to the point that it is no longer statistically significant when a covariance adjustment is made for scores on the measure of sex-role identification.

Table 1

Analysis of Covariance: Sex Differences in Problem Solving with Adjustment for Terman-Miles M-F Score

Source of Variation	Sum of Squares	d. f.	Mean Square	F	p
Before Adjustment					
Between	48	1	48	5.16	.05
Within	716	77	9.30		
Total	764	78			
After Adjustment					
Between	14.26	1	14.26	1.77	-
Within	612	76	8.05		
Total	626	77			

The correlations between the sex-role score and the problem-solving score within a sex are shown in Table 2. These correlations are significant, as they were in the earlier experiments.

Table 2

Correlations of Sex-Role Identification and Intelligence with Problem Solving

	Men	Women	Combined
Terman-Miles M-F Test	.33*	.48**	.42**
Otis Mental Abilities	.59**	.54**	

* **In this and all subsequent tables in this Technical Report, correlation coefficients marked with one asterisk are significant at the .05 level and coefficients marked with two asterisks are significant at the .01 level.

However, the independent contribution within a sex of the sex-role measure to problem solving is not significant for the males when it is combined in a multiple prediction equation with the Otis Test of Mental Ability. The appropriate Beta weights are presented in Table 3. There is no evidence of significant lack of linearity in these relationships.

Table 3

Beta Weights: Relative Independent Contribution of Each of the Variables to Problem Solving Score

	Men	Women
Terman-Miles M-F Test	.14	.31*
Otis Mental Abilities	.54**	.41**

In the earlier study (Milton, 1957) the contribution of sex role to problem solving within a sex was found to be significant, independent of intelligence, for both sexes. The lack of obtained independent significance in the present experiment is probably due to the higher correlation between the Otis and the Terman-Miles (.36 for men and .42 for women) than was obtained between the Terman-Miles and the College Board Examination scores used in the previous study (.26 was the highest obtained). The factors involved in this higher relationship are difficult to ascertain since the direction of causality might be argued to proceed either way. Further work will be needed to determine the significance of this particular finding with respect to the hypothesis that sex-role identification contributes to achievement in problem solving.

There was a pronounced difference between the sexes on the oral mucosa smear measure, with a mean of 4.64 for the men in contrast to a mean of 23.27 for the women. However, this measure did not relate significantly to either problem solving or sex-role identification as measured by the Terman-Miles M-F. Table 4 presents these results.

Table 4

Correlation of Sex-Role Identification
and Problem Solving with Oral Mucosal Smear

	Men	Women
Terman-Miles M-F Test	.00	.07
Problem Solving Score	.12	-.09

There is no evidence of a significant curvilinearity in this data.

None of the correlations computed between items from the biographical questionnaire and either sex-role identification or problem solving proved to be significant.

Discussion

The results of this experiment provide a replication, in general, of the previously reported relationship between masculine-role identification and achievement in problem solving. They do not, however, shed much light on the origins of this relationship. Although the negative finding with the oral smear technique certainly does not support an hereditary biological interpretation of the relationship, neither does it disprove it. The oral mucosal cells are only one of many types of body cells displaying a sex difference, and these cells are certainly far removed from the processes of cerebration. Furthermore, Herrmann has expressed the opinion (personal communication) that the distributions obtained for the sexes may be artifactual, i.e. with perfect techniques all cells from women would contain the stained particle, while none from the men would contain the particle. In any event, if the possibility that biological factors contribute to the relation between sex role and problem solving is to be further explored, some other approach must be taken. Perhaps a study of the chemical activity of the cortex or a study of metabolic rates may prove more fruitful. However, it is the author's opinion that more profitable results will be obtained from a further study of the acquired and motivational aspects of the relation between sex role and problem solving.

Summary

A positive correlation between sex-role identification and problem-solving skill was obtained both within and across sexes for 37 female and 42 male high school students. When problem-solving scores are adjusted for this relationship, sex differences in problem solving become non-significant. When an oral mucosal smear test was used as a measure of genetic sexuality, such scores showed no significant relation either to sex-role identification or to achievement in problem solving. Personal history data also failed to show significant correlations with either of the latter two measures.

References

Greenblatt, R. B., de Acosta, O. M., Vasquez, E., & Mullins, D. F. Oral mucosal smears in the detection of genetic sex. *J. Amer. Med. Assoc.*, 1956, 161(8), 23.

Herrmann, W. & Davis, A. M. The determination of chromosomal sex by oral smears. Yale J. Biol. Med., 1956, 29, 69-74.

Milton, G. A. The effects of sex-role identification upon problem-solving skill. J. abnorm. soc. Psychol. 1957, 55, 208-212.

Sweeney, E. J. Sex differences in problem solving. Stanford: Dept. Psychol., Stanford Univer., 1953 (Tech. Rep. 1, Contract N6onr 25125).

Terman, L. M. & Miles, Catherine C. Sex and personality. New York: McGraw-Hill, 1936.

SEX DIFFERENCES IN PROBLEM SOLVING AND ROLE APPROPRIATENESS OF PROBLEM CONTENT

Earlier studies have shown that there is a consistent sex difference in problem solving, and that this may be partially accounted for in terms of the sex-role identification of the subjects solving the problems (see pp. 1-7). The present investigation has as its focus the role appropriateness of the problems which subjects are required to solve. The principal hypothesis may be stated as follows: When the characteristics of problems are altered so as to make them less appropriate to the masculine sex role, the sex differences in problem-solving skill will be reduced. In addition, the relationship of the effects of alteration of sex-role appropriateness of the content upon the correlation between problem solving and identification within a sex is investigated.

Preliminary Survey

In order to modify the role-appropriateness of the content of the problem-solving task, it was necessary to determine the nature of masculine and feminine role content. Tyler (personal communication) has shown that the sex differences in interest exist well before children begin their public school career, and Terman and Miles (1936) have traced these differences through adulthood. Hartley and Klein (1957) have linked such differences to the role dimension and shown that subjects even in pre-adolescence have a stable knowledge of what is and is not role-appropriate behavior.

Knowledge of these studies was in part used as the basis for altering the content of the problems, but the final alteration was based upon preliminary survey data obtained directly from the population to be sampled. Sixty Stanford undergraduates, 30 male and 30 female, were asked to report the kinds of problem-solving situations which they encountered in their everyday lives. The resulting problems were then categorized for each sex group by two judges working independently[1], and the apparent sex differences in the content of the problems were noted. The inter-judge reliability was .76.

In order to demonstrate that alteration of the problems was a meaningful procedure, 30 problems were taken from the conventional problem-solving literature, including problems used by the author (Appendix 1) and by Sweeney (1953) which had been based upon those developed by Duncker, Guetzkow, and others. These 30 problems were given independently to two judges[2] with the instructions to categorize them according to the categories developed in the preliminary survey described above. The content of the 30 problems fell into "masculine" categories for 77 per cent of the problems for one judge and 83 per cent of the problems for the other judge. Chi square was significant beyond the .01 level in both cases. The inter-judge reliability was .72 for individual categories. Thus it seems that alteration of the conventional problems to make them less masculine is a meaningful procedure.

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[1] Two advanced graduate students in psychology who had no direct knowledge of the author's hypotheses.

[2] Two Ph.D.'s in psychology who were currently serving clinical internships at the Palo Alto Veteran's Hospital, and who had no direct knowledge of the author's hypotheses.

Method

Construction of Problems. In order to test the hypothesis, two parallel sets of problems were required. One set must be in the form conventional to the problem-solving literature, the other set must be in a form which makes it more appropriate to the feminine sex role, or less appropriate to the masculine role. These sets were formed by choosing 20 problems of the conventional sort and then constructing a parallel set in which the tasks remained the same but in which the content of the problems had been altered to be more appropriate to the female role. Role appropriateness was based upon the preliminary survey described above.

An example may serve to illustrate the manner in which the alterations were made. The conventional problem chosen from earlier experiments reads:

> Snuffy, the tramp, rolls his own cigarettes from butts he collects in his travels. The tobacco from six butts produces one new cigarette. One day he collected a total of 72 butts. He smoked a cigarette every half hour, yet this supply lasted him seven hours. How did he manage this?

The parallel problem in the female-role appropriate form is:

> Sally, the cook, cuts cookies from batter she makes each morning. She rolls out six cups of batter to cut one dozen round cookies. One day she made a total of 72 cups of batter. She sold a dozen cookies every half hour, yet this supply lasted her seven hours. How did she manage this?

The complete set of parallel problems will be found in Appendix 3.

Arrangement of Problems. Even though the task in each member of a problem pair was assumed to be equivalent to that for the other member of the pair, a partially random order of presentation of content was chosen so as to eliminate any possible effects of systematic differences other than those due to role appropriateness of the content. A problem booklet containing 20 problems was prepared for each subject. Ten of the problems in each booklet were in the masculine content form and ten were in the feminine content form. No booklet contained the same task in both sex-role forms. The order of tasks was the same for all booklets, but the role appropriateness of the content was partially randomized, the only conditions being that 10 masculine and 10 feminine problems be included in each booklet and that each problem be given equal representation over the whole group. An example may help clarify this arrangement:

Order of Tasks

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Booklet A	f	f	f	m	f	f	m	m	m	f	m	m	m	f	m	m	f	f	f	m
Booklet B	m	f	f	f	m	f	f	m	m	m	f	m	m	m	f	m	m	f	f	f

For every booklet prepared for a male subject, an identical booklet was prepared for a female subject, but no two members of the same sex had identical booklets.

Subjects. The problem booklets and the Terman-Miles M-F Test (1936) were given to 25 male and 25 female undergraduates from an introductory psychology class at Stanford University. These Ss had volunteered to participate in order to fulfill a course requirement. All 50 subjects were tested in one group.

Results

The results pertaining to the principal hypothesis of the experiment were analyzed by the analysis of variance technique which McNemar has designated as Case XVII (1955, p. 332). Two tests are important in this analysis. First, the test of differences between blocks will demonstrate the presence or absence of over-all sex differences on these problems. Second, the test of block by column interaction will indicate whether or not there is an interaction effect of role appropriateness with sex. This second test is the crucial test of the principal hypothesis. By this hypothesis we expect the difference between problem-solving scores of men and women to be less under conditions of female-role appropriateness than under conditions of male-role appropriateness. The mean scores for each sex under each condition are presented in Table 1 and the results of the variance analysis are presented in Table 2.

Table 1

Mean Number of Problems Solved

Problem Content	Men	Women	Difference	p
Masculine	4.68	3.04	1.64	.01
Feminine	4.00	3.56	.44	-

Table 2

Analysis of Variance: Number of Problems Solved

Source of Variation	Sum of Squares	d. f.	Mean Square	F	p
Individuals	214.72	48	4.47		
Sex	27.04	1	27.04	6.04	.01*
Problem Content	0.16	1	0.16		-
Sex x Problem Content	9.00	1	9.00	3.97	.05*
Remainder	108.84	48	2.27		
Total	350.76				

*One-tailed test

It is clear from Tables 1 and 2 that the results of this experiment confirm the principal hypothesis. The men solve, on the average, more problems than do the women, but the difference between men and women is reduced when the problems are framed in content appropriate to the feminine role.

Table 3 presents the correlations within each sex between scores on the Terman-Miles M-F Test and number of problems solved. The problems which are appropriate to the male role show a significant correlation with masculine role identification both among men and among women. This result confirms earlier findings (see p. 4). For the feminine-role-appropriate problems, however, the correlations are not significant, and, in fact, the sign is reversed for the women.

Table 3

Correlation of Terman-Miles M-F Scores with
Number of Problems Solved

	Problem Content		
	Masculine	Feminine	Combined
Men	.41*	.30	.42*
Women	.38*	-.21	.16

Discussion

The results of this experiment suggest that to the extent that problems can be made more appropriate to the feminine role or less appropriate to the masculine role, the sex differences in problem-solving achievement are diminished. Moreover, a similar process seems to operate within a sex since both men and women who score in the masculine direction on the M-F test solve more male-role problems than the members of their sex who score in the feminine direction, but there is no significant relationship between M-F score and number of female-role problems solved.

This seems to indicate that a fairly transitory motivational aspect is more important in problem solving than some previous explanations of the sex-difference phenomena had suggested (Milton, 1957). It is not entirely that men have a better developed "general reasoning" capacity or that they have learned more skill, but apparently that they are responding in part merely to the stimulus properties, which in the case of problem-solving research has been predominantly appropriate to the male role. This may not be entirely a motivational response, for it might be argued that Ss are more familiar with materials appropriate to their own role, but since the tasks involved in the two different sets of problems were virtually identical the major effect would seem due to the motivational aspect.

This result also suggests an important implication concerning the improvement and measurement of problem-solving skills in women. In order to achieve maximum results in either case, it seems advisable to frame the problem-solving tasks in content appropriate to the sex role. This may, in many ways, be more efficient than trying to convince women that problem solving of the conventional sort _is_ role appropriate.

Summary

A preliminary survey showed that college men and women solve different types of problems habitually, and that problems conventional to psychological research are more often typically masculine. A set of 20 problems were presented half with content appropriate to the male role and half with content appropriate to the female role to 50 college undergraduates. The results confirmed the hypothesis that when the characteristics of problems are altered so as to make them less appropriate to the masculine sex role, the sex differences in problem-solving skill will be reduced.

References

Hartley, R. E. & Klein, A. Sex-role concepts among elementary-school-age girls. Paper read at meetings of the American Psychological Association, 1957.

McNemar, Q. *Psychological statistics*. New York: Wiley, 1955.

Milton, G. A. The effects of sex-role identification upon problem-solving skill. *J. abnorm. soc. Psychol.* 1957, *55*, 208-212.

Sweeney, E. J. *Sex differences in problem solving*. Stanford: Dept. Psychol., Stanford Univer., 1953 (Tech. Rep. 1, Contract N6onr 25125).

Terman, L. M. & Miles, Catherine C. *Sex and personality*. New York: McGraw-Hill, 1936.

CHOICE OF STRATEGY FOR SOLVING PROBLEMS AND SEX ROLE

During previous research which explored some of the relations between sex role and problem solving (see pp. 1-16) the author noted an apparent tendency for women to use a different mode of approach to problems than do men. Several different modes of approach to problem solving have been noted in the literature (Taylor and McNemar, 1955), but three strategies which are readily apparent are: (a) Seeking help; (b) Trial and error; (c) ~~[illegible]~~ Analysis or abstraction. The present study examined the choice of strategies by men and by women in the problem solving situation.

The hypotheses of this experiment were based more upon the observation of subjects in previous experiments than upon any set of formal theories. It was expected that (a) men and women would differ in choice of strategy; (b) an interaction between choice of strategy and sex-role appropriateness of the content of problems would be obtained; (c) a relationship between choice of strategy and sex-role identification within a sex would be obtained similar to that between sexes.

Method

Subjects. Forty male and 40 female Stanford undergraduates participated as subjects in this experiment. They volunteered as participants in order to fulfill a course requirement in general psychology.

Measure of Choice of Strategy. A 16-item forced-choice test was constructed and pretested. Each item presented a single problem together with three alternative methods for solving it, these alternatives representing the three strategies mentioned earlier. The subjects were first required to choose the one of the three alternatives which they would use in solving the problem. Next, they were required to choose the one alternative which seemed to be the best method for solving the problem. The instructions given to the subjects were as follow:

> Sixteen problems are presented below. Each problem is followed by a number of methods by which it could be solved. Since all of the methods lead to a correct solution, you do not need to solve the problem. Your task is to decide two things: (Y) Which of the methods is the one you would probably have used if you had been solving the problem. (B) Which method, given all those described, seems best. For each problem put one check mark under Y for your probable choice of method and one under B for the best method. Both checks may, of course, follow the same method.

The 16 problems consisted of eight appropriate to the male role and eight appropriate to the female role. The complete series is given in Appendix 4. Role appropriateness was determined by the pretesting process described in the previous experiment (p. 10). An example of an item appropriate to the female role is:

> You're a new cook and you notice that Sally, the experienced cook, cuts cookies from batter she makes each morning. She rolls out six cups of batter to cut one dozen round cookies. One day she made a total of 72 cups of batter. She sold a dozen cookies every half hour, yet this supply lasted her seven yours. You wonder how she did this.

	Y	B
1. You asked Sally to tell you the secret.	( )	( )
2. You tried out different methods of cookie cutting until you discovered the secret.	( )	( )
3. You thought it all out, using mathematics, until suddenly you realized the secret.	( )	( )

An example of an item appropriate to the male role is:

You know that an automobile dealer ordered 1,000 tires one day. This was enough for four tires for each car and two tires for each motorcycle he had on hand. Altogether he had 296 vehicles. You want to know how many cars and how many motorcycles he had.

	Y	B
1. You tried several combinations of numbers until you came up with 92 motorcycles and 204 cars.	( )	( )
2. You realized you were dealing with a simple algebra problem and worked it out.	( )	( )
3. You asked the automobile dealer.	( )	( )

This test yielded six different scores for each subject with respect to "choice of strategy" and six additional scores with respect to "best strategy"; the several scores, however, were not independent. A single score was simply the number of times a given strategy was selected by a member of a given sex for problems appropriate to a given sex role.

The Terman-Miles M-F test (1936) was used as the measure of sex-role identification, as in the previous studies in this series.

Results

The sex differences in choice of strategy and the relationship between choice of strategy and role appropriateness of the problems will be examined first. These results were analyzed by the analysis of variance method used in the previous study (pp. 12-13). A separate analysis was computed for each strategy and for each best strategy. Because of the non-independent nature of the forced choice test, no over-all test was made. Tables 1 through 6 present the results of these analyses.

Table 1-A

Mean Number of Times Subjects Would Have Used Analytic Strategy

	Problem Content		
	Masculine	Feminine	Both
Men	3.52	5.45	8.97
Women	2.55	4.12	6.67
Difference			2.30

Table 1-B

Analysis of Variance: Number of Times Subjects Would Have Used Analytic Strategy

Source of Variation	Sum of Squares	d. f.	Mean Square	F	p
Individuals	233.88	78	3.00		
Sex	52.90	1	52.90	17.64	.001
Problem Content	122.50	1	122.50	93.44	.001
Sex x Problem Content	1.23	1	1.23	.93	-
Remainder	102.28	78	1.31		
Total	512.78				

Each of the six analyses of variance presents three F-ratios, testing respectively the significance of the difference in means between the sexes, the difference in means between problems presented in masculine and in feminine form, and of the interaction between sex and problem content. Only the first and third of these tests of significance are of interest in each case.

Table 2-A

Mean Number of Times Subjects
Chose Analytic Strategy as Best

	Problem Content		
	Masculine	Feminine	Both
Men	3.85	4.98	8.83
Women	4.65	5.28	9.93
Difference			-1.10

Table 2-B

Analysis of Variance: Number of Times
Subjects Chose Analytic Strategy as Best

Source of Variation	Sum of Squares	d. f.	Mean Square	F	p
Individuals	198.28	78	2.54		
Sex	12.10	1	12.10	4.76	.05
Problem Content	30.63	1	30.63	23.22	.001
Sex x Problem Content	2.50	1	2.50	1.90	-
Remainder	102.88	78	1.32		
Total	346.38				

An F-ratio indicating that the mean for the masculine problems differed significantly from the mean for the feminine problems is of little interest. This is true because the eight problems presented in masculine form differed from the eight presented in feminine form not only in appropriateness of cotent, but also in that they were simply different problems. Hence, a signficant difference in means may be the result either of the difference in role appropriateness or other other differences between

Table 3-A

Mean Number of Times Subjects Would Have Used Trial-and-Error Strategy

	Problem Content		
	Masculine	Feminine	Both
Men	2.35	.88	3.23
Women	2.40	1.75	4.15
Difference			- .92

Table 3-B

Analysis of Variance: Number of Times Subjects Would Have Used Trial-and-Error Strategy

Source of Variation	Mean Squares	d. f.	Mean Square	F	p
Individuals	157.04	78	2.01		
Sex	8.56	1	8.56	4.25	.05
Problem Content	45.16	1	45.16	31.01	.001
Sex x Problem Content	6.81	1	6.81	4.68	.05
Remainder	113.54	78	1.46		
Total	331.09				

the two particular sets of eight problems employed, this latter being trivial. Since the design confounds these two effects, the F for problem content will be ignored in examining the results of the several analyses.

From Tables 1 and 2 it can be seen that there were significant differences between the sexes in their choice of the analytic strategy. The men more often than the women indicated that they would have used analysis, but the women more often said that the analytic strategy was the best one. In neither case was there a significant interaction between

Table 4-A

Mean Number of Times Subjects Chose Trial-and-Error as Best Strategy

	Problem Content		
	Masculine	Feminine	Both
Men	1.50	1.28	2.78
Women	1.28	1.25	2.53
Difference			.25

Table 4-B

Analysis of Variance: Number of Times Subjects Chose Trial-and-Error as Best Strategy

Source of Variation	Sum of Squares	d. f.	Mean Square	F	p
Individuals	90.48	78	1.16		
Sex	.63	1	.63	.54	-
Problem Content	.63	1	.63	.73	-
Sex x Problem Content	.40	1	.40	.47	-
Remainder	66.98	78	.86		
Total	159.10				

sex and the role appropriateness of the content of the problems.

As in indicated in Table 3, there was also a significant difference between men and women in the choice of the trial-and-error strategy for use, more women than men indicating that they would have used it. In this case, there was also a significant interaction between role appropriateness and sex in determining choice of strategy. However, when it came to designating trial-and-error as the best strategy, no significant difference between the sexes was obtained.

Table 5-A

Mean Number of Times Subjects
Would Have Used Strategy of Seeking Help

	Problem Content		
	Masculine	Feminine	Both
Men	2.12	1.68	3.80
Women	3.05	2.12	5.17
Difference			-1.37

Table 5-B

Analysis of Variance: Number of Times
Subjects Would Have Used Strategy of Seeking Help

Source of Variation	Sum of Squares	d. f.	Mean Square	F	p
Individuals	161.09	78	2.07		
Sex	18.91	1	18.91	9.16	.01
Problem Content	18.91	1	18.91	15.12	.001
Sex x Problem Content	2.26	1	2.26	1.91	-
Remainder	92.34	78	1.18		
Total	293.49				

It is indicated in Tables 5 and 6 that although women would tend to use the strategy of seeking help more often than men do, there was apparently no significant difference in the designation of this as the best strategy.

A general overview of these results indicates that there were significant sex differences in the choice for use of all three strategies, with the men choosing the abstract strategy more often than the women,

Table 6-A

Mean Number of Times Subjects Chose Strategy of Seeking Help as Best

	Problem Content		
	Masculine	Feminine	Both
Men	2.65	1.75	4.40
Women	2.08	1.48	3.56
Difference			.84

Table 6-B

Analysis of Variance: Number of Times Subjects Chose Strategy of Seeking Help as Best

Source of Variation	Sum of Squares	d. f.	Mean Square	F	p
Individuals	153.75	78	1.97		
Sex	7.23	1	7.23	3.67	-
Problem Content	22.50	1	22.50	21.51	.001
Sex x Problem Content	.90	1	.90	.86	-
Remainder	81.60	78	1.05		
Total	265.98				

and the women choosing the manipulative strategy and the strategy of seeking help more often than men. The choice of the strategy which would have been used did not coincide with the strategy designated as best as far as these average statistics indicate. In only one case was there a significant interaction between sex and role-appropriateness of the problem content in determining the choice of strategy.

Correlations with Sex-Role Identification. The correlations of the various choices of strategy with the Terman-Miles M-F test were determined. These are presented in Table 7.

Table 7

Correlations of Terman-Miles with Choice of Strategy

	"Would Have Used"		"Best"	
	Masculine	Feminine	Masculine	Feminine
Analytic Strategy				
Men	.29*	.36*	-.05	.20
Women	-.02	.30*	-.17	.09
Combined	.32**	.53**	-.25*	.00
Trial-and-Error				
Men	-.24	.08	-.04	-.15
Women	-.06	-.05	.09	.12
Combined	-.11	-.27*	.10	-.02
Seeking Help				
Men	-.10	-.51**	.08	-.08
Women	.08	-.30*	.13	-.17
Combined	-.24*	-.40**	.23*	.01

A general summary of the correlational relationships obtained between the choice of strategies and sex-role identification corresponds with the sex difference data. The results for the sexes combined demonstrate the relationship for subjects irrespective of sex membership. A comparison of these combined results with those for the sexes taken independently indicates that in most cases masculinity and belonging to the male sex have similar effects in determining the choice of strategy. The choice of the analytic strategy correlated positively with, and the choice of a strategy of seeking help negatively with, masculine-role identification. The results for designation of best strategy were inconsistent. It is clear, however, that choice of strategy for use was not dependent simply upon which strategy a subject designated by best.

Discussion

The results of this experiment fit together to form a pattern suggesting that sex role plays a part in determining the choice of a strategy for solving problems. Men and the masculine-role-identification are associated with the choice of an analytic approach, women and the feminine-role-identification with seeking help. Moreover, women indicate more frequently than men that they would use trial-and-error, although no significant correlation between role-identification and use of trial-and-error was found within either sex. However, these findings apply only to the choice of solution and not to the effectiveness of solution. Further work is needed to determine whether these differences in strategy preferences contribute to sex differences in achievement in problem solving or to the relationship between sex-role identification and such achievement.

Summary

Forty college men and 40 college women were asked to indicate which of three methods they would have used in solving each of 16 problems, half of which were presented in masculine and half in feminine form. They were also asked to indicate which of the three methods was the "best." The three alternative methods presented for each problem included one which involved an analytic strategy, one involving trial-and-error, and one involving seeking help.

The men indicated significantly more frequently than the women that they would have used the analytic strategy, whereas the women more frequently than the men would have used trial-and-error and seeking help. Moreover, within each sex, masculinity tended to be correlated with the use of an analytic strategy, while femininity was correlated with the use of a strategy of seeking help. There was no consistent relation between sex or sex role and designation of best strategy.

References

Taylor, D. W. & McNemar, Olga W. Problem solving and thinking. In Stone, C. P. (ed.) Annual Review of Psychology. Palo Alto, Calif.: Annual Reviews, Inc., 1955, 6, 455-482.

Terman, L. M. & Miles, Catherine C. Sex and personality. New York: McGraw-Hill, 1936.

SEX DIFFERENCES IN PROBLEM SOLVING AS RELATED TO ROLE APPROPRIATENESS OF PROBLEM CONTENT AND TO AVAILABILITY OF MANIPULATIVE MATERIALS

The first study in the present series (pp. 1-7) confirmed previous findings that men are superior to women in solving at least certain kinds of problems (Sweeney, 1953; Carey, 1955; Nakamura, 1955; Milton, 1957) and that this sex difference in problem solving is reduced to insignificance when adjustment is made for differences in sex-role identification (Milton, 1957). The second study (pp. 8-16) showed that altering the content of problems to make them more appropriate to the feminine role also reduces the sex difference in achievement. In the third study (pp. 17-28), data were obtained indicating that men more often than women would tend to use an analytic strategy, while women more often than men would tend to use a trial-and-error strategy (also, seeking help); the data also indicate that within either sex the tendency to use an analytic strategy is correlated with masculine-role identification.

The results of these studies taken together suggest that the superior achievement of men may be accounted for by the greater tendency to use an analytic strategy, and that the correlation within either sex between masculinity and achievement in problem solving may similarly be accounted for by a correlation between masculinity and tendency to use analytic strategy. No evidence is available from the previous studies to support the assumption implicit here that the use of analytic strategy would be more effective in solving the particular problems employed than would the use of trial-and-error.

In the present study, problems were presented in an "abstract" form intended to foster the use of analytic strategy and in a "manipulative" form intended to both foster and aid the use of trial-and-error. The "abstract" form involved simply presenting the problem reproduced upon a sheet of paper together with a pencil and space in which to work out the solution. The "manipulative" form involved presenting the same materials and in addition certain objects which could be manipulated and whose manipulation might aid in the solution of the problem. It was thought that the availability of these manipulative materials might both encourage and facilitate the use of trial-and-error.

The study provided a comparison of the number of problems solved when presented in the abstract form with the number solved when presented in the manipulative form. But of more interest was the expectation that since women tend more than men to use a trial-and-error as opposed to an analytic strategy, they would tend to do relatively better on problems presented in manipulative as contrasted to abstract form. The hypothesis of primary interest was: When the use of a trial-and-error strategy is fostered and aided by making available manipulative materials, the sex difference in problem solving will be reduced.

In this experiment, as in the second one in the present series, each problem was also presented with content appropriate both to a masculine and to a feminine role. Hence, the design also provided another test of the principal hypothesis of that previous study: When the content of problems is altered so as to make them less appropriate to the masculine role, the sex differences in problem solving will be reduced.

Method

Subjects. Sixty boys and sixty girls from the North Haven High School participated as subjects in this experiment. The group included nearly all of the individuals in the senior class and also a few from the junior class, the latter being added to obtain the total number required. Scores on the California Short-Form Test of Mental Maturity (Sullivan, Clark and Tiegs, 1950) were available from school records for all students as a measure of intelligence. There was no significant sex difference in I. Q., the boys having a mean of 103.8 and the girls a mean of 103.6.

Materials. Twenty problems were employed, all of which were identical to, or modifications of, problems used in previous studies in this series. Appendix 5 lists the problems employed and describes whatever modifications were made. Each of the twenty problems was used both with masculine and with feminine content and both in an abstract and in a manipulative form.

The following is an example of the same problem in masculine and in feminine form:

> An automobile dealer ordered 38 tires one day. This was enough to provide four tires for each car and two tires for each motorcycle he had on hand. Altogether he had 12 vehicles. How many cars and how many motorcyles did he have?
>
> A bride's mother ordered 38 candles for her daughter's wedding. This was enough to provide four candles for each four-stem candlestick and two candles for each two-stem candlestick she had on hand. Altogether she had 12 candlesticks. How many two-stem candlesticks and how many four-stem candlesticks did she have?

When the latter was presented in manipulative form, two toy candelabra, one holding two candles and the other four, were provided together with 40 birthday candles. When the former was presented in manipulative form, one toy car and one toy motorcycle was provided together with 40 toy tires (or more accurately, 40 small rubber washers chosen to resemble toy tires). Each boy and each girl received all twenty problems, five in each one of the four possible forms: abstract-masculine (Am), abstract-feminine (Af), manipulative-masculine (Mm), and manipulative-feminine (Mf).

The Terman-Miles M-F test (1936) was used as the measure of sex-role identification, and a short biographical data sheet was also used.

Procedure. Subjects were tested in six groups, each group consisting of 10 men and 10 women. All tests were given during one session of approximately 2½ hours for each group. The 20 problems were given first with a five-minute break between the first set of 10 and the second set. This was followed by the biographical data sheet and the Terman-Miles. There was a timekeeper-proctor for each five subjects.

Subjects were placed, alternately by sex, at two long tables seating 10 subjects each. A screen on the table top separated each subject from the subjects on either side. The problems were passed from subject to subject by the proctors. The following instructions were presented orally and in written form before each testing session:

> Directions: This is a test of your ability to solve certain kinds of problems. This experiment is part of a program of research on problem solving.
>
> The problems included here have been carefully selected on the basis of preliminary experimentation to provide a test of certain hypotheses concerning processes important in problem solving. The success of the experiment depends upon each of you doing as well as possible on each of the problems. Your best effersts will be very much appreciated.
>
> You will be given a total of 20 problems to solve. Four minutes will be allowed for each problem. There will be a break at the end of the first 10 problems. At any given time each of you will be working on a different problem and you will not all be given the same problems to solve.

In front of you there is a box. Please do not open the box until the signal to start is given. Each box contains one problem. When you are told to start, open the box and take out everything that is in it.

Some boxes contain only a sheet of paper with one problem written on it. Other boxes contain materials which will help you to solve the problem. Be sure to use the materials if they are present, but it may not be necessary to use all of them.

When you open a box, first find the sheet with the problem on it and write your code number on that sheet. Write only on this sheet, never on any of the materials.

After you are finished working on a problem and feel sure that you have written the correct answer on your problem sheet, raise your hand and your proctor will write the time on your sheet. Then put the sheet in your envelope.

There is one proctor for each five of you and each proctor has a stop watch.

Next, put any materials back in the box and push the box up to the left hand corner of your section of the table. (Leave the lid off.)

Please sit quietly until the instruction to begin the next problem is given.

When you are told to begin the next problem, pull the box from the upper right hand corner of your section, and begin.

You will probably not be able to finish many of the problems. If you do not finish, please stop when the stop signal is given and go on to the next problem.

One final word—some of these have materials which are fun to work with, or even funny, but the purpose is very serious. Please do not make any comment or noise during the experiment. Please do not even ask questions once the experiment is begun. All the information you will need is given in the statement of the problem. If you are puzzled, re-read the problem carefully.

Also, since other students will be participating in this experiment after you, please do not tell anybody any of the problems which you are given to solve, because they may be serving as subjects later this week or next week. If you tell someone about a problem, they will not be able to take part.

Four sets of problems were employed. Each set included all 20 problems, five in each of the four possible forms. The composition of each of the four sets is shown in Table 1. Within a group of 10 subjects receiving one of the four sets, each subject started on a different problem, but then received the remaining problems in the same order, Problem 1 following Problem 20. Thus, for example, Subject A started with Problem 1, then went to 2, 3, 4 ... 20, and Subject B started with Problem 3, then went to 4, 5, ... 20, 1, 2. Furthermore, the method of administration was such that any given set and order was given equally frequently to boys and to girls. All the problems were timed as described in the instructions.

Table 1

Four Sets of Problems*

Problem	Set 1	Set 2	Set 3	Set 4
1	Mf	Am	Mm	Af
2	Af	Mm	Am	Mf
3	Mm	Af	Mf	Am
4	Am	Mf	Af	Mm
5	Mf	Am	Mm	Af
6	Af	Mm	Am	Mf
7	Mm	Af	Mf	Am
8	Am	Mf	Af	Mm
9	Mf	Am	Mm	Af
10	Af	Mm	Am	Mf
11	Mm	Af	Mf	Am
12	Am	Mf	Af	Mm
13	Mf	Am	Mm	Af
14	Af	Mm	Am	Mf
15	Mm	Af	Mf	Am
16	Am	Mf	Af	Mm
17	Mf	Am	Mm	Af
18	Af	Mm	Am	Mf
19	Mm	Af	Mf	Am
20	Am	Mf	Af	Mm

*Upper-case letters refer to strategy, lower-case to role appropriateness. Mm = manipulative-masculine. Mf = manipulative-feminine. Am = abstract-masculine. Af = abstract-feminine.

Results

Because the design employed involved three main effects, the results can not be easily summarized in a single two-dimensional table. Tables 2 and 3, therefore, summarize the data with respect to mean number of problems solved by men and by women as dependent upon the two experimental conditons.

Table 2

Mean Number of Problems Solved as Related to Sex and to Availability of Manipulative Materials

		Problem Form		
	All Problems	Abstract	Manipulative	Difference
Combined	5.35	2.63	2.72	- .09
Men	5.88	2.79	3.09	- .30
Women	4.82	2.47	2.35	.12
Difference	1.06	.32	.84	

Table 3

Mean Number of Problems Solved as Related to Sex and to Role Appropriateness of Problem Content

		Problem Content		
	All Problems	Masculine	Feminine	Difference
Combined	5.35	2.92	2.43	.49
Men	5.88	3.19	2.69	.50
Women	4.82	2.65	2.17	.48
Difference	1.06	.54	.52	

The results of the analysis of variance are presented in Table 4.

Table 4

Analysis of Variance: Number of Problems Solved

Source of Variation	Sum of Squares	d. f.	Mean Square	F	p
Individuals	301.98	118	2.56		
Sex	8.27	1	8.27	3.23	.05*
Prob. Form: Abstr. vs. Manip.	.25	1	.25	.10	-
Prob. Content: Masc. vs. Fem.	7.25	1	7.25	3.00	-
Sex x Problem Form	1.30	1	1.30	.53	-
Sex x Problem Content	.002	1	.002	.001	-
Prob. Form x Prob. Content	.17	1	.17	.07	-
Sex x Form x Content	1.47	1	1.47	.61	-
Remainder_1	285.31	118	2.42		
Remainder_2	291.01	118	2.47		
Remainder_3	283.76	118	2.41		
Total	603.00	479			

*One-tailed test only for the sex difference

Only the sex difference was significant, the boys as usual solving more problems than the girls. The mean number of problems solved in abstract form did not differ from the mean number solved in manipulative form, nor did the mean number with masculine content solved differ from the mean number with feminine content solved

More important, neither the interaction between sex and problem form nor the interaction between sex and problem content was significant.

The data thus fail to confirm the primary hypothesis of this study, namely that encouraging and facilitating the use of trial-and-error strategy by making available manipulative materials will reduce the sex difference in problem solving. Similarly, and surprisingly, the present data fail to confirm the hypothesis that had previously found support in the second study of this series, namely that altering the content of problems to make them less appropriate to the masculine role will reduce the sex difference in problem solving.

Time Scores. A record was available of the time required by each subject to solve each problem, assuming that he solved it within the four-minute time limit. An analysis of these time scores provided no additional information of interest, at least partly because of the fact that on the average less than a third of the problems were solved (Tables 2 and 3). Hence, the results will not be presented here.

Correlations of Sex-Role Identification with Problems Solved. Another analysis of interest in the relation of sex-role identification to problem solution within each of the sexes. It will be recalled that in earlier studies a signficant positive correlation was obtained both among men and among women between masculinity and problem solving when the problems were predominantly masculine in content (see p. 4, also p. 14). When the problems were stated in feminine terms, the correlations did not differ significantly from zero. The data from the present study, shown in Table 5, essentially confirm the earlier findings. An additional finding of interest is that the correlation between masculinity and problem solving also fails to reach significance when the problems are presented in the manipulative form, the form thought to foster and aid the trial-and-error strategy for which women were previously found to have greater preference.

Table 5

Correlations of Terman-Miles M-F Scores with Number of Problems Solved

	All Problems	Problem Content Masculine	 Feminine	Problem Form Abstract	 Manipulative
Men	.29*	.30*	.20	.25*	.26*
Women	.25*	.25*	.19	.26*	.16

Effects of Order upon Problem Solving. The design of the experiment was such that each problem was presented an equal number of times in each of the twenty possible positions, this being true both for men and for women. This aspect of the design makes it possible to explore the effect of the position in which a problem is presented upon the probability of its solution. Figure 1 presents this information in graphic form both for men and for women. The curves have been smoothed.

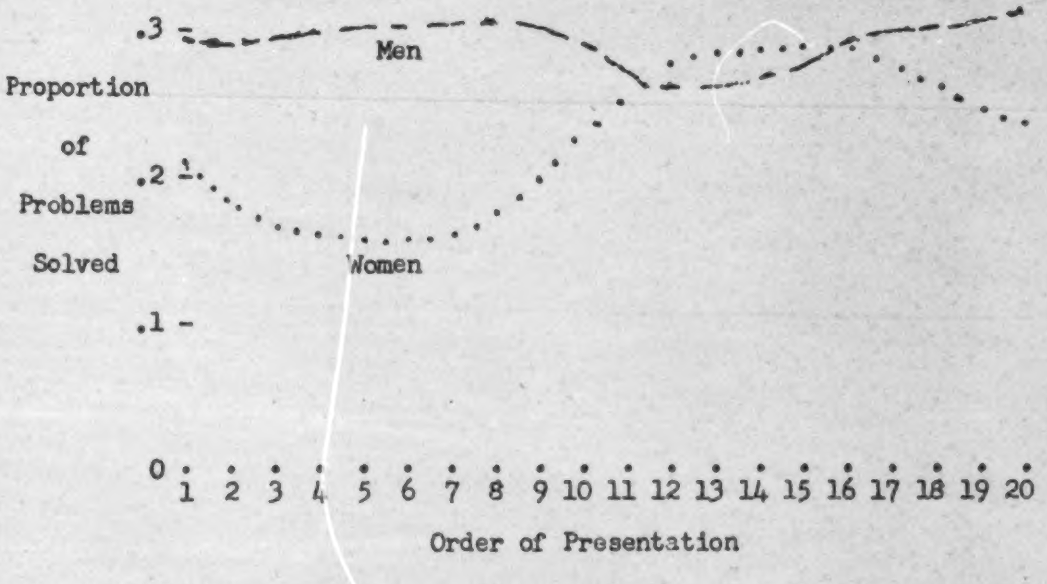


Fig. 1. Proportion of Problems Solved as a Function of Order of Presentation

There is no apparent overall effect of order common to both sexes such, for example, as that which might result from fatigue. What is of interest is the difference between men and women with respect to the effect of order. The unanticipated finding is that the superior performance of men occurred largely during the first half of the problems.

Discussion

In this as in several previous studies (see p. 29), the mean number of problems solved by men was significantly larger than the mean number solved by women, even though the mean I. Q.'s for the two groups were almost identical. The present study was undertaken primarily to explore the possibility that this sex difference results in part from a difference between the sexes in the strategies which they tend to use in solving problems. The study preceding this one had provided evidence that men tend more than women to use an analytic strategy and that women tend more than men to use a trial-and-error strategy. It seemed probable that providing manipulative materials would encourage the use of a trial-and-error strategy and also increase its effectiveness. This expectation led to the formulation of the hypothesis that making available such materials would reduce the sex difference in problem solving. The data, however, fail to provide any support for this hypothesis. One point should be kept in mind in interpreting this result. It appears probable that making available manipulative materials would both foster and aid the use of trial-and-error, but no evidence is available that this in fact occurred. However, the data in any case provide no positive evidence that the sex difference in problem solving results even in part from a difference between the sexes in strategies employed.

Data was obtained in the second study in this series (pp. 8-16) suggesting that motivational factors are important in accounting for the sex difference and problem solving and for the relation within each sex between sex-role identification and such achievement. In that study as in this one, a significant positive correlation was obtained between masculinity and problem solving both among men and among women when the problems were presented with masculine content. But in both studies presenting the problems with feminine content reduced these correlations to insignificance. Furthermore, presenting the problems with feminine content reduced the sex difference in problem solving to insignificance. Since the same tasks were involved with masculine as with feminine content, these findings favor a motivational interpretation rather than one involving differences in strategy.

It must be noted quickly, however, that the present study failed to confirm this finding of the second study. In this study, presenting the problems with feminine content resulted in no reduction in the sex difference in achievement. There is no completely satisfactory explanation for this failure to confirm the earlier study, but there are at least three major differences between this study and the previous one. These differences deserve examination: (a) The subjects in this study were high school students; those in the other study were college students. (b) Manipulative materials were present in the present study but not in the other one. (c) Proctors were present and observing the subjects closely in the present study but not in the other one.

The difference between high school and college subjects does not appear to be a satisfactory explanation for the lack of confirmation, because other aspects of the sex role and problem solving relationship have been obtained with both groups (see pp. 1-7). Also, if the presence of manipulative materials, per se, were responsible for the present lack of confirmation, this should have been indicated by a significant three-way interaction. However, if the presence of manipulative materials had a more general effect, i.e., one which generalized to all problems, this would not necessarily have produced a significant three-way interaction. Since the presence and absence of manipulative materials was directly alternated in the design, this possibility of generalized effect cannot be eliminated. The presence of observant proctors is also worth considering since this could have had the effect of forcing continued effort even upon less interesting (e.g., non-role-appropriate) problems.

Either of the last two explanations would have their effect through the motivation of the subjects, but there are no data in the present study through which the motivation can be gauged. A weak sort of evidence for the higher motivation of the present group of subjects comes from a comparison of the total problem-solving scores of the present group with those of another high school group (p. 4) to whom somewhat similar problems were given without close proctoring. The present group solved significantly more problems ($t = 2.13$ for the men and 3.40 for the women). This is consistent with the explanation that the subjects were more highly motivated in the present study, but is by no means conclusive since the problems were not identical for the two groups and since we cannot equate the two groups for intelligence. (Different intelligence tests were used.)

Another piece of minimal evidence occurs in the present study which, by ad hoc reasoning, is consistent with the motivational interpretation of the effects of sex role. This is the finding that women increased in number of problems solved over the problem series while men remained relatively constant. This interpretation of the finding assumes that the initial motivational effect upon women confronted with the series of problems is negative, but that this negative motivation diminished with time, due to increased task involvement and an awareness that some of the problems were appropriate to the feminine role. Certainly the motivational interpretation is consistent with Carey's finding that women increase their problem solving performance after a group discussion (Carey, 1958).

Summary

The hypothesis of primary interest was: When the use of a trial-and-error strategy is both fostered and aided by making available manipulative materials, the sex difference in problem solving will be reduced. The design also provided another test of the principal hypothesis in the second study in this series: When the content of problems is altered so as to make them less appropriate to the masculine role, the sex difference in problem solving will be reduced.

Sixty boys and sixty girls from the North Haven High School were given 20 individually-timed problems to solve. Half of the problems were presented in abstract form and half with manipulative materials available. Half of the problems contained content appropriate to the masculine role and half content appropriate to the feminine role. The Terman-Miles M-F test was used as a measure of sex-role identification.

As usual, the mean number of problems solved by the men was significantly more than the mean number solved by women. The mean number solved in abstract form did not differ significantly from the mean number solved in manipulative form, nor did the mean number solved with masculine content differ from the mean number solved with feminine content. More important, neither the interaction between sex and problem form nor the interaction between sex and problem content were significant. The data, thus, not only failed to confirm the hypothesis of primary interest in this study, but also failed to confirm the hypothesis for which support had been found in the results of the second study in this series.

Scores on the Terman-Miles were again found to be significantly correlated among men and among women with achievement in problem solving for masculine but not for feminine problems. Such scores also correlated with achievement within both sexes for abstract problems, but for women failed to show such significant correlation for manipulative problems.

References

Carey, Gloria L. Reduction of sex differences in problem solving by improvement of attitude through group discussion. Stanford: Dept. Psychol., Stanford Univer. (Tech. Rep. 9, Contract N6onr 25125). Also appeared as: Carey, Gloria L. Sex differences in problem solving performance as a function of attitude differences. J. abnorm. soc. Psychol., 56, 256-260.

Milton, G. A. The effects of sex-role identification upon problem solving skill. J. abnorm. soc. Psychol., 55, 219-244.

Nakamura, C. Y. The relation between conformity and problem solving. Stanford: Dept. Psychol., Stanford Univer. (Tech. Rep. 11, Contract N6onr 25125). Also appeared as: Nakamura, C. Y. Conformity and problem solving. J. abnorm. soc. Psychol., 56, 315-320.

Sullivan, E. T., Clark, W. W. & Tiegs, E. W. California Short-Form Test of Mental Maturity. Los Angeles: California Test Bureau, 1950.

Terman, L. M. & Miles, Catherine C. Sex and personality. New York: McGraw-Hill, 1936.

SEX DIFFERENCES IN PROBLEM SOLVING AND ROLE APPROPRIATENESS OF PROBLEM CONTENT: A REPLICATION

Both the second and the fourth study in this series included a test of the hypothesis: When the characteristics of problems are altered so as to make them less appropriate to the masculine role, the sex differences in problem solving will be reduced. Data obtained in the second study supported the hypothesis, whereas data obtained in the fourth study failed to confirm. The two studies differed in that the former employed as subjects Stanford undergraduate men and women, whereas the latter employed North Haven High School boys and girls. They differed also in that the latter included the use of manipulative materials with half of the problems and involved the use of proctors to time students individually.

The present study was intended essentially to replicate the second study to see whether the same finding would again be obtained.

Method

Twenty problems were employed, each appearing both with masculine-role-appropriate and with feminine-role-appropriate content. These were the same problems which had been employed in abstract form in the fourth study (see Appendix 5), problems which involved some minor modifications of the series of 20 problems originally employed in the second study (see Appendix 3). In the present study, no manipulative materials were available, nor were the problems individually timed. All problems for an individual subject were bound in a single booklet, and a working time of 80 minutes permitted for the entire set. Each subject received 10 problems with masculine content and 10 with feminine content, the design being such that an equal number of men and women received each problem with masculine and with feminine content. Twenty-four undergraduate men and 24 undergraduate women from the University of Colorado served as subjects.

Results

Tables 1 and 2 summarize the results. Men and women differed signicantly in the mean number of problems solved. More important, the interaction between sex and problem content was significant, thus support-

Table 1

Mean Number of Problems Solved

Problem Content	Men	Women	Difference	p
Masculine	5.71	3.29	2.52	.001
Feminine	4.99	3.83	1.16	.05

Table 2

Analysis of Variance: Number of Problems Solved

Source of Variation	Sum of Squares	d. f.	Mean Square	F	p
Individuals	246.79	46	5.37		
Sex	77.04	1	77.04	14.36	.001
Problem Content	.18	1	.18	.08	-
Sex x Problem Content	9.37	1	9.37	4.42	.05
Remainder	97.46	46	2.12		
Total	430.84				

ing again the hypothesis first confirmed in the study here being replicated. There is one difference in the results of the two studies. In this study, unlike the second one, the sex difference in number of problems solved still significantly favors the men even for problems presented with feminine content (Table 1).

Discussion

Additional support is provided to the interpretation of the effect of sex role upon problem solving as being in part a transitory motivational effect by this replication confirming the results of the second study. In both of these two studies, the problems with content appropriate to the sex role were solved by greater facility by members of that sex than were problems appropriate to the opposite sex role. This motivational effect may be either one of enchancement of effort on problems appropriate to the role, or aversion to problems not appropriate to the sex role. Perhaps both factors are involved. Carey (1958) has demonstrated that men have more favorable attitudes toward abstract problem solving than do women. The author has unpublished data which confirms this and which shows that women have higher anxiety than do men in the problem solving situation. Thus, both positive and negative motivation seems to be operating.

The failure in the fourth study to find a reduction in sex differences in problem solving when problems with feminine content were presented may be explainable in terms of differences in subject population, presence of manipulative materials, or use of individual timing of problems by proctors. The present emphasis upon motivational factors would tend to favor the last of these three. The use of proctors individually timing problems may have served to maximize the motivation of both sexes and hence to reduce the likelihood of an interaction depending upon motivational factors.

This emphasis upon motivational factors in the influence of sex role upon problem solving is by no means intended to convey the conclusion that such factors are the only ones operating to produce differences between men and women in problem solving or to produce within either sex a relation between sex-role identification and achievement in problem solving. Ann explanation, for example, is still needed for the fadt that in the present study men solved more problems than women even when those problems were presented with feminine content.

Summary

Twenty-four undergraduate men and 24 undergraduate women were given a set of 20 problems, half with content appropriate to the masculine role and half with content appropriate to the feminine. role. The results confirm an earlier finding that when the characteristics of problems are altered so as to make them less appropriate to the masculine role, sex differences in problem solving are reduced.

APPENDIX 1

PROBLEM BATTERY FOR THE FIRST EXPERIMENT

Directions: This is a test of your ability to solve certain kinds of problems. This experiment is part of a program of research on problem solving.

The problems included here have been carefully selected on the basis of preliminary experimentation to provide a test of certain hypotheses concerning processes important in problem solving. The success of the experiment depends upon each of you doing as well as possible on each of the problems. Your best efforts will be very much appreciated.

Each of the twenty problems has a four-minute time limit. If you finish a problem before the end of the time limit, use the extra time to recheck your answer. Please do NOT go on to the next problem until thesignal is given. Please do NOT go back to an earlier problem which you were unable to complete. When the signal is given, please turn the page immediately and begin work on the next problem.

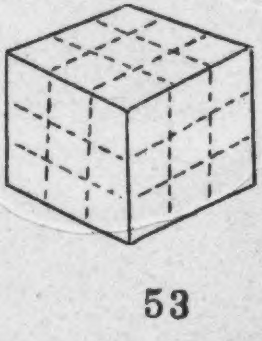
Do whatever figuring is necessary in the space provided, but be sure your answer is clearly indicated. Draw a circle around it if necessary. One final word--please do NOT discuss any of these problems with other students. They may wish to take part in this same experiment.

1. If 7 men can do a job in 21 days, how many days will it take 3 men to do the same job?

2. The diagram below represents a three-inch cube painted white on all six sides. The dotted lines represent cuts made through the large cube to divide it into one-inch cubes.

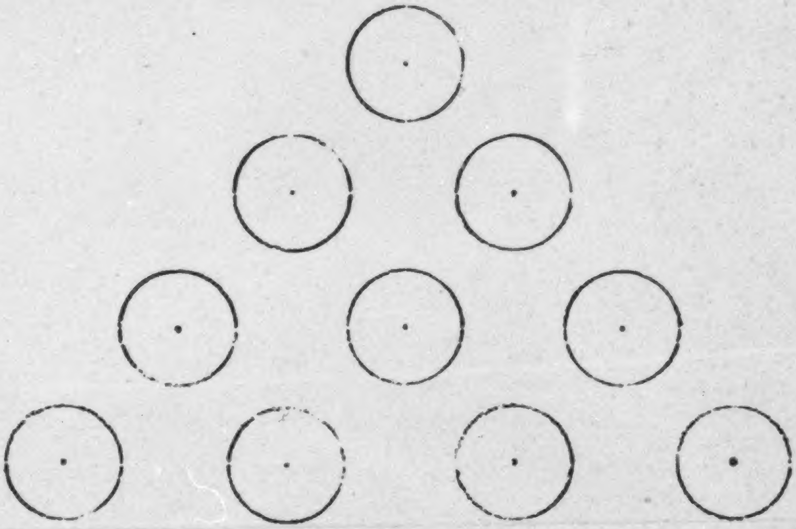
How many of the one-inch cubes have one white side? ________

How many have two white sides? ________



3. Snuffy, the tramp, rolls his own cigarettes from butts he collects in his travels. The tobacco from six butts produces one new cigarette. One day he collected a total of 72 butts. He smoked a cigarette every half hour, yet this supply lasted him seven hours. How did he manage this?

4. The triangle below is made up of 10 pennies. Show how you could move only 3 of the pennies to turn the triangle upside down--make it point down instead of up.



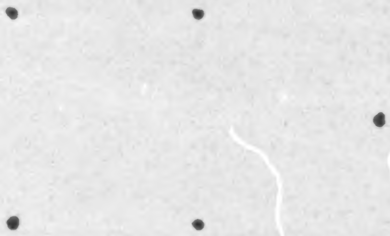
5. The average of a set of numbers is defined as their sum divided by n. If John had an average score of 83 on three tests, and if his first two tests had the average score 88, what score did he receive on the third test?

6. Finish filling in the square with the numbers 1 through 9 so that the sum of all vertical, horizontal, and diagonal rows will be 15.

	1	
	5	
	9	

7. A snail starts at the bottom of a well 12 feet deep and crawls up 4 feet each day. Each night, however, the poor thing slips back 3 feet. How long will it take the snail to reach the top of the well?

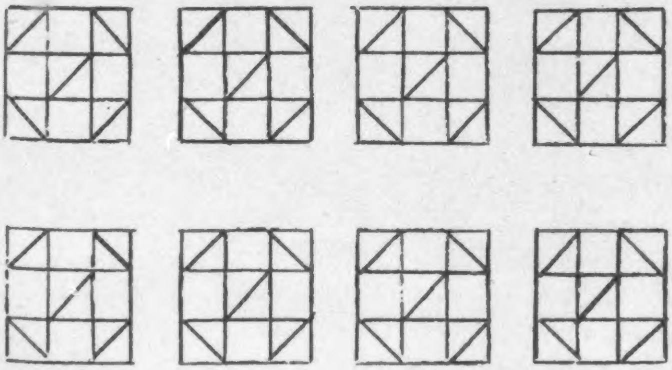
8. Connect all these dots using only three straight lines, without lifting your pencil from the paper and without retracing any line. The lines may cross each other.

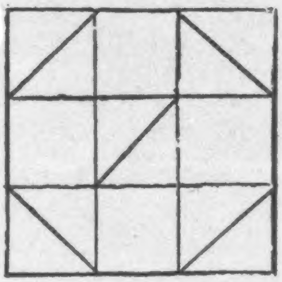


9. A, B, and C together have $96. B has twice as much as C, and A has as much as B and C together. How much has B?

10. It is possible to make a unicursal tracing of the figure below--that is, to go completely around every portion of the figure without ever lifting your pencil from the paper or retracing a line.

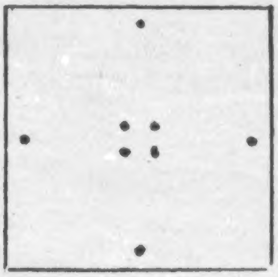
The problem is to make such a tracing. The large copy of the figure is to be traced, when you have found out how to do it by practicing on the small copies. For every try, draw a small circle around the place where you begin the tracing.





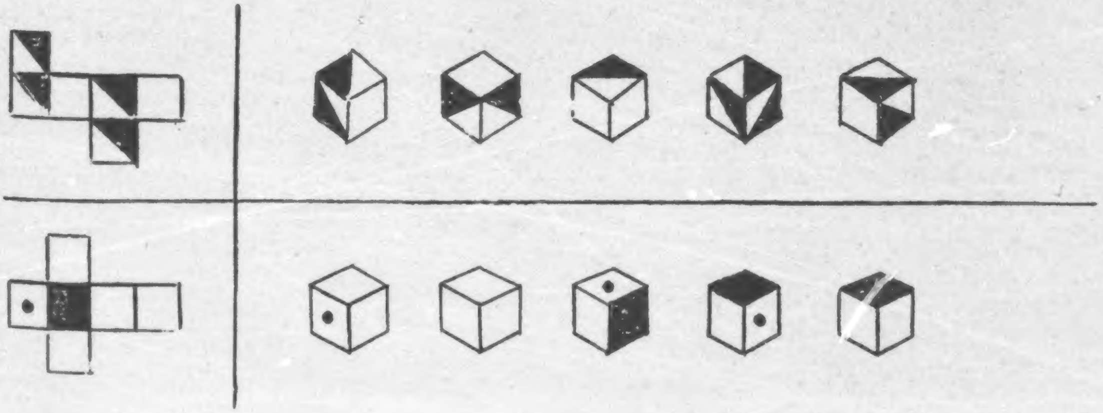
11. Suppose a simple organism, like an amoeba, divides into two once every three minutes. Every new organism divides into two every three minutes. A single amoeba is placed in a jar and in one hour the jar is filled with amoebae. How long will it take to fill the jar if we start with two amoebae instead of one?

12. Use straight lines to divide this square into four parts of the same size and shape, without drawing any of the lines through any of the dots.



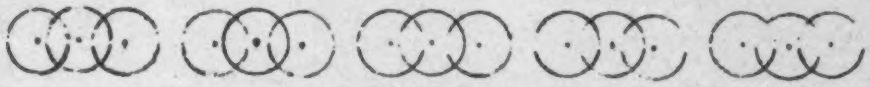
13. An automobile dealer one day ordered 1,000 tires. This was enough to provide four tires for each car and two tires for each motorcycle he had on hand. Altogether he had 296 vehicles. How many cars and how many motorcycles did he have?

14. The figure at the left represents a piece of cardboard which can be folded to make a box. The figures to the right represent various boxes. Consider both the shape of the boxes and the sides which have been painted black. Draw a circle around each of the boxes on the right which could have been made from the cardboard on the left.



15. No human being has more than five million hairs on his head. This fact plus some information that the Bureau of Census can provide would permit you to prove that there are at least two persons in New York City who have the same number of hairs on their heads. What information would you need and how could it be used to prove the proposition?

16. A man has five pieces of chain. Each piece is made up of three links. He wants to join the five pieces into a single length of chain. What is the smallest number of links that he must open and close in order to do this? ______
Explain how it would be done.



17. A stranger bought a bicycle for $15 and gave in payment a check for $25. The dealer went to a neighboring store and cashed the check. The stranger received $10 change, mounted his bicycle, and disappeared. The check bounced and the dealer had to make good. The bicycle cost the dealer $11. How much money did he lose altogether?

18. Four married couples want to get to the top of a building. There is no way to do this except by means of an elevator which any of the eight people can operate, but which will not hold more than three people at a time. The husbands (call them A, B, C, and D) are jealous men, and none of them will permit his wife to be in the presence of another man at any time, even momentarily, unless he is also there.

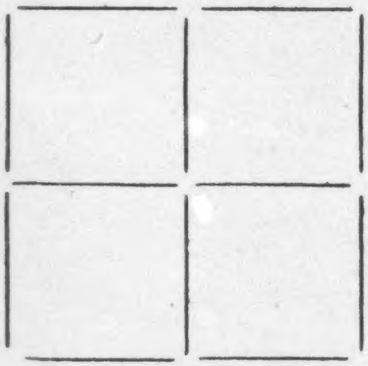
How do the four couples get to the top of the building? Call the wives, a, b, c, and d (a is married to A, and so on). List the trips it is necessary for the eight people to make up and down on the elevator.

For example, on the first trip wives, a, b, and c go up, and wife a comes down; next a and d go up, and a comes down. You go on from there.

(up) 1. a, b, c
(down) 2. a
3. a, d
4. a
5. ________
6. ________
7. ________
8. ________
9. ________
10. ________

19. How can you bring up from the river exactly six quarts of water when you have only a four quart and a nine quart pail to measure with?

20. The four squares below are made up of 12 matches. Make a drawing to show how by moving only three of the matches you can make only three squares, all of which will be the same size as the original square.



APPENDIX 2

QUESTIONNAIRE

Name ______________________________ Age _______ Sex _________

About you:

What do you want to do when you are through school? __________________

Who do you want to be like when you get older? ______________________

What kind of a job would you like to have? __________________________

Who is the nicest person you know? __________________________________

Who is the kindest person you know? _________________________________

Who is the sternest person you know? ________________________________

When you grow older do you want to be more like your mother or your father? ___________________ Why? _____________________________

Do you ever get angry at your parents? ___________ Which one do you get mad at most often? _____________ Why? ____________________

Boys: Do you ever wish you had been born a girl? ______

Have you ever had the feeling that your parents wish you were a girl? ______

Girls: Do you ever wish you had been born a boy? ______

Have you ever had the feeling that your parents wish you were a boy? ______

About your family:

How many brothers do you have? ___________ How old are they? _______

How many sisters do you have? ____________ How old are they? _______

How old is your father? _______ How old is your mother? _______

What is your father's occupation? ______________________________

What is your mother's occupation? ______________________________

Have you ever lived away from your father or mother? ____ Why? ____

_______________________ How old were you? ________________

Do you have a step-mother or step-father? ________________________

Who is really the boss in your family? __________________________

Do your parents ever disagree about how you should behave? _____ Who is more strict? _______________

How often were you spanked when you were a child? _______________

How were you punished usually? _____________ Who punished you most often? ________________

APPENDIX 3

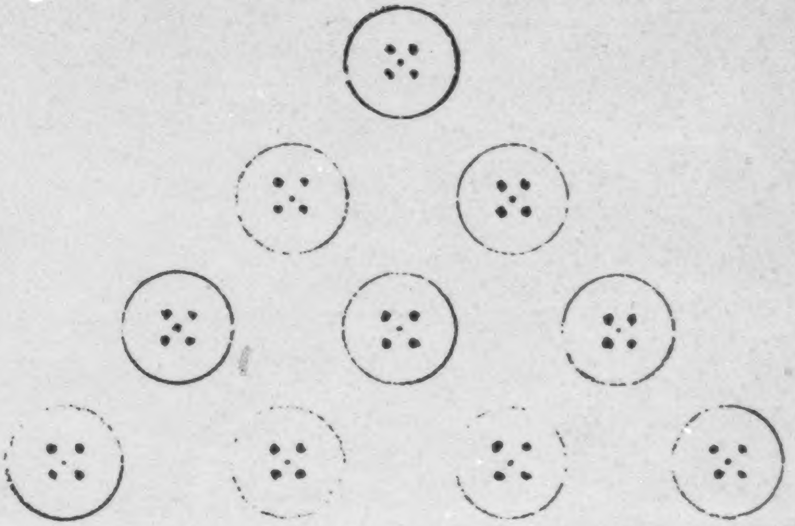
PARALLEL SETS OF MASCULINE AND FEMININE ROLE APPROPRIATE PROBLEMS

The first problem of a pair is in the feminine role form, and the second problem is in the masculine form.

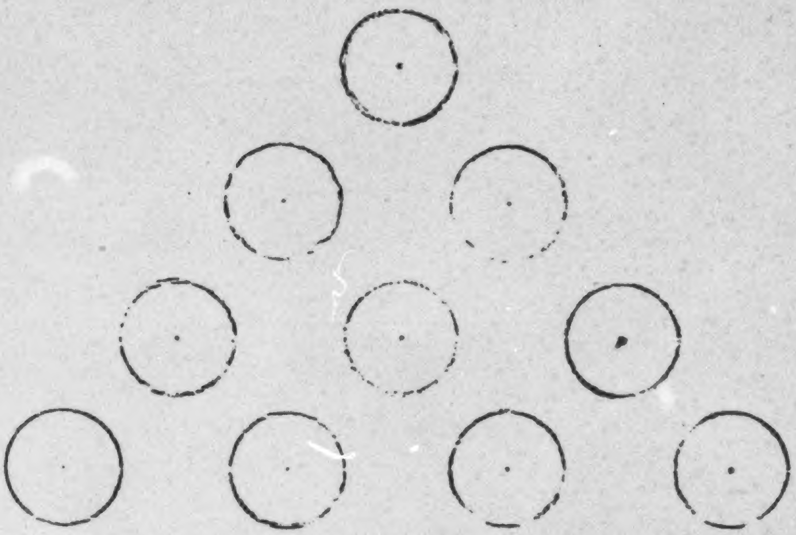
F1. Sally, the cook, cuts cookies from batter she makes each morning. She rolls out six cups of batter to cut one dozen round cookies. One day she made a total of 72 cups of batter. She sold a dozen cookies every half hour, yet this supply lasted her seven hours. How did she manage this?

M1. Snuffy, the tramp, rolls his own cigarettes from butts he collects in his travels. The tobacco from six butts produces one new cigarette. One day he collected a total of 72 butts. He smoked a cigarette every half hour, yet this supply lasted him seven hours. How did he manage this?

F2. The triangle below is made up of 10 buttons. Show how you could move only 3 of the buttons to turn the triangle upside down--make it point down instead of up.



M2. The triangle below is made up of 10 pennies. Show how you could move only 3 of the pennies to turn the triangle upside down--make it point down instead of up.



F3. An airplane has three stewardesses: the senior stewardess, the junior stewardess, and the nurse. Their names are Miss Smith, Miss Jones, and Miss Robinson, but not necessarily in that respective order. There are also three passengers having the same last names as the stewardesses; i.e., Smith, Jones, and Robinson, but since the passengers are married, they are identified as Mrs. in the following statements.

1. Mrs. Robinson is from Detroit.
2. The nurse lives half-way between Chicago and Detroit.
3. Mrs. Jones bleaches her hair.
4. Miss Smith beat the junior stewardess, her roommate, at cribbage.
5. The nurse's neighbor, one of the passengers, has darker hair than the nurse.
6. The passenger whose name is the same as the nurse lives in Chicago.

From the given information, figure out the name of the senior stewardess.

____________________ Why?

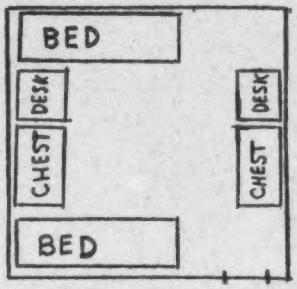
M3. An airplane is crewed by three men: the pilot, the co-pilot, and the navigator. Their names are Smith, Jones, and Robinson, but not necessarily in that respective order. There are also three passengers on the plane having the same names as the crew members, *i.e.*, Smith, Jones, and Robinson. In the following statements the passengers are identified as *Mr.*

1. Mr. Robinson is from Detroit.
2. The navigator lives half-way between Chicago and Detroit.
3. Mr. Jones earns $6200 per year.
4. Smith beat the co-pilot, a neighbor, at billiards.
5. The navigator's nearest neighbor, one of the passengers, earns three times as much as the navigator who makes $6300 per year.
6. The passenger whose name is the same as the navigator lives in Chicago.

From the given information, figure out the name of the pilot.

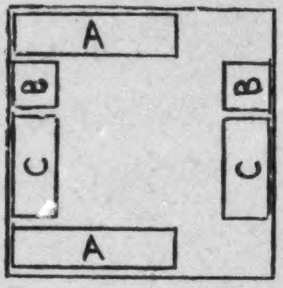
____________________ Why?

F4. Two roommates want to re-arrange their furniture so that each would have exactly one half of the room. The present furniture arrangement is given below. What is the minimum number of pieces of furniture they will have to move? ______ Show how the room would be divided.



M4. The problem presented below is how to arrange the position of the three small rectangles, A, B, and C in the large rectangle, so that the large rectangle can be divided exactly in half. Each half of the large rectangle must contain one A, one B, and one C rectangle. What is the minimum number of small rectangles which must be moved? _______ Show how the large rectangle would be divided.

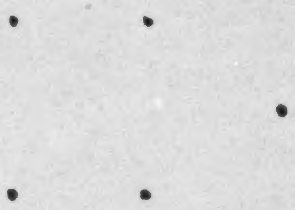
(Diagram on following page.)



F5. If 7 women can make a quilt in 21 days, how many days will it take three women to make the same quilt?

M5. If 7 men can do a job in 21 days, how many days will it take three men to do the same job?

F6. As a problem in interior decorating, Barbara had to connect all these dots using only three straight lines, without lifting her pencil from the paper and without retracing any line. The lines may cross each other. Show how it can be done.



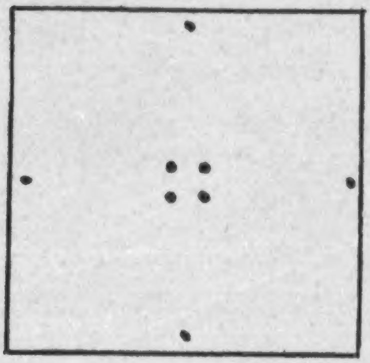
M6. As a problem in engineering, Frank had to connect all these dots using only three straight lines, without lifting his pencil from the paper and without retracing any line. The lines may cross each other. Show how it can be done.

(Same figure as above.)

F7. Jane is trying to lose 12 pounds so that she may try on a new dress. By careful dieting she loses 4 pounds each week. Each weekend, however, the poor girl gains back 3 pounds. How long will it take before she can try on the dress?

M7. A snail starts at the bottom of a well 12 feet deep and crawls up 4 feet each day. Each night, however, the poor thing slips back 3 feet. How long will it take the snail to reach the top of the well?

F8. Use straight lines to show how you could cut this birthday cake into four pieces of the same size and shape, without drawing any of the lines through any of the candles (dots on the drawing).



M8. Use straight lines to divide this square into four parts of the same size and shape, without drawing any of the lines through any of the dots.

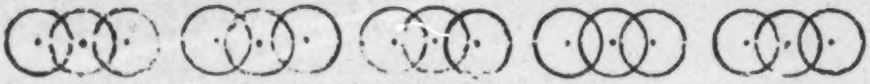
(Same figure as above.)

F9. Suppose that you are interested in how fast a rumor spreads through a girls' dormitory. One girl can tell another girl the news once in three minutes. Every new girl can tell another girl the news once in three minutes. If one girl gets a piece of information it takes one hour for the news to get all around the dorm. How long will it take for a rumor to cover the whole dorm if two girls hear it at the same time?

M9. Suppose a simple organism, like an amoeba, divides into two once every three minutes. Every new organism divides into two every three minutes. A single amoeba is placed in a jar and in one hour the jar is filled with amoebae. How long will it take to fill the jar if we start with two amoebae instead of one?

F10. A girl has five pieces of a necklace. Each piece is made up of three links. She wants to join the five pieces into a single length of necklace. What is the smallest number of links that she must open and close in order to do this? ____________ Explain how it would be done.

(Figure on the next page.)



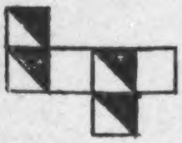
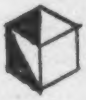
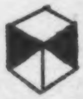
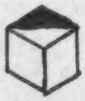
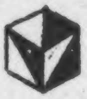
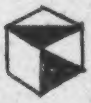
M10. A man has five pieces of chain. Each piece is made up of three links. He wants to join the five pieces into a single length of chain. What is the smallest number of links that he must open and close in order to do this? _________ Explain how it would be done.

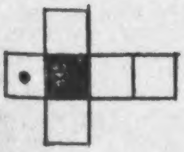
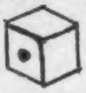
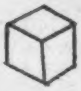
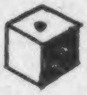
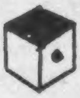
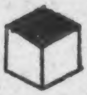
(Same figure as above.)

F11. Joan, Dorothy, and Barbara together have 36 dresses. Dorothy has twice as many as Barbara, and Joan has as many as Dorothy and Barbara together. How many dresses has Joan?

M11. John, David, and Robert together have $36. David has twice as much as Robert, and John has as much as David and Robert together. How much money has John?

F12. The figure at the left represents a piece of cloth which can be used to cover a square cushion. The figures to the right represent various cushions. Draw a circle around each of the cushions on the right which could have been covered by the cloth on the left.

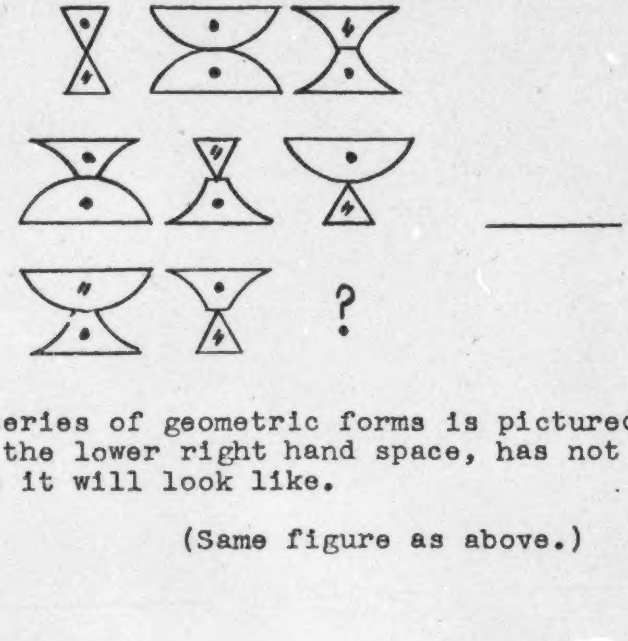
M12. The figure at the left represents a piece of cardboard which can be folded to make a box. The figures to the right represent various boxes. Draw a circle around each of the boxes on the right which could have been made from the cardboard on the left.

(Same figure as for F12.)

F13. An unknown woman bought a bracelet for $15 and gave in payment a check for $25. The dealer went to a neighboring store and cashed the check. The woman received $10 change, took her bracelet, and disappeared. The check bounced and the dealer had to make it good. The bracelet cost the dealer $11. How much money did he lose altogether?

M13. An unknown man bought a bicycle for $15 and gave in payment a check for $25. The dealer went to a neighboring store and cashed the check. The stranger received $10 change, mounted his bicycle, and disappeared. The check bounced and the dealer had to make it good. The bicycle cost the dealer $11. How much money did he lose altogether?

F14. A series of modern vases are pictured below. The last vase, in the lower right hand space, has not yet been drawn. Show what it will look like.



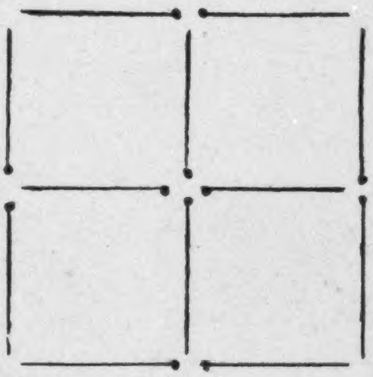
M14. A series of geometric forms is pictured below. The last form, in the lower right hand space, has not yet been drawn. Show what it will look like.

(Same figure as above.)

F15. An interior decorator ordered 1,000 yards of drapery material. This was enough to provide four yards for each long drape and two yards for each short drape she had on order. Altogether she had orders for 296 drapes. How many long drapes and how many short drapes had been ordered?

M15. An automobile dealer ordered 1,000 tires one day. This was enough to provide four tires for each car and two tires for each motorcycle he had on hand. Altogether he had 296 vehicles. How many cars and how many motorcycles did he have?

F16. The decorative design below consists of four squares made out of 12 pearl-headed pins. Make a drawing to show how, by moving only three pins, you can make a new design consisting of three squares, each the size of the original squares.



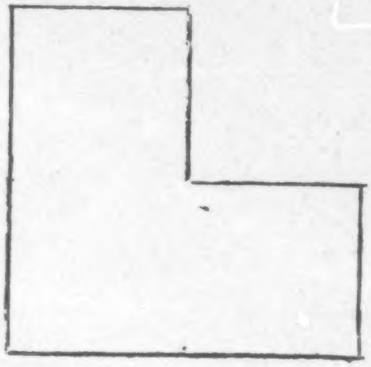
M16. The four squares below are made up of 12 matches. Make a drawing to show how by moving only three of the matches you can make only three squares, all of which will be the same size as the original squares.

(Same figure as above.)

F17. How can you measure out exactly six cups of flour when you only have a four-cup container and a nine-cup container to measure with? (Flour is in a large bin.)

M17. How can you measure out exactly six quarts of motor oil when you have only a four-quart container and a nine-quart container to measure with? (Oil is in a large barrel.)

F18. The figure below shows the outline of a small house. Draw lines to show how the rooms could be arranged so that there are four rooms which are equal in size and shape.



M18. The figure below shows three-quarters of a square. Draw lines to show how the figure could be divided into four parts which are equal in size and shape.

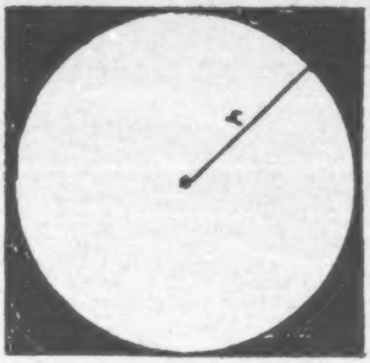
(Same figure as above.)

F19. Of seven diamonds, one is a synthetic. It looks just like the others, but it weighs less. Using a pair of balance scales, it is possible to find the gem that is the false one in no more than two weighings. How can this be done?

M19. Of seven coins, one is a counterfeit. It looks just like the others, but it weighs less. Using a pair of balance scales, it is possible to find the coin that is the false one in no more than two weighings. How can this be done?

F20. The figure below represents material from which a skirt is to be cut. The shaded area is waste material. The radius of the skirt is 1 yard. (The area of the circle is about 3 times the radius squared. How much material will be wasted.

(Figure on following page.)



M20. The figure below represents sheet metal from which a disk is to be cut. The shaded area is waste metal. The radius of the disk (circle) is 1 yard. (The area of the circle is about 3 times the radius squared.) How much metal will be wasted?

(Same figure as above.)

APPENDIX 4

SOLUTIONS TEST

Name ______________________________ Date ______________ Sex: M F

Directions: Sixteen problems are presented below. Each problem is followed by a number of methods by which it could be solved. Since all of the methods lead to a correct solution, you do not need to solve the problem. Your task is to decide two things: Y) Which of the methods is the one you would probably have used if you had been solving the problem. B) Which method, given all those described, seems best. For each problem put one check mark under Y for your probable choice of method and one under B for the best method. (Both checks, may, of course, follow the same method.)

You have 15 minutes in which to complete the test. The examiner will tell you when to begin.

EXAMPLE:	Y	B
1.	( )	( )
2.	(x)	( )
3.	( )	(x)

---

1. You want to plan your delivery route so that it would be most efficient. You have 35 stops to make during a 7 hour period, and you need to be at the warehouse at the beginning and end of the route.

		Y	B
1. You take a city map and work out the route plan in your head.	1.	( )	( )
2. You consult the route manager who has had many years experience.	2.	( )	( )
3. You drive around the route, trying out several different delivery patterns.	3.	( )	( )

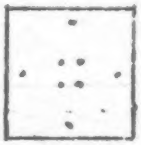
2. You and your two room-mates want to make quilts for Christmas presents. You know that seven people can make a quilt in 21 days and you need to know how many days it will take three of you to make a quilt.

		Y	B
1. You make a sample quilt to find out.	1.	( )	( )
2. You ask an experienced seamstress.	2.	( )	( )
3. You work it out mathematically.	3.	( )	( )

3. You're a new cook and you notice that Sally, the experienced cook, cuts cookies from batter she makes each morning. She rolls out six cups of batter to cut one dozen round cookies. One day she made a total of 72 cups of batter. She sold a dozen cookies every half hour, yet this supply lasted her seven hours. You wonder how she did this.

		Y	B
1. You asked Sally to tell you the secret.	1.	( )	( )
2. You tried out different methods of cookie cutting until you discovered the secret.	2.	( )	( )
3. You thought it all out, using mathematics, until suddenly you realized the secret.	3.	( )	( )

4. The engineering instructor gives you the square below to divide into four parts of the same size and shape, without drawing any of the lines through any of the dots.



		Y	B
1. You look through some engineering books until you come up with it.	1.	( )	( )
2. You turn the problem over in your head until you come up with it.	2.	( )	( )
3. You draw several trial lines until you come up with it.	3.	( )	( )

5. You have a flat tire (right rear) and need to put on the spare, but you have no jack. The only tools you have are a lug wrench and a tire pump, but there are some blocks beside the road.

		Y	B
1. You reason out that if you put blocks under the middle and tip the car you can change the tire.	1.	( )	( )
2. You flag down a passing car and ask if they have a jack.	2.	( )	( )
3. You try several methods of placing the blocks until you discover that the center placement solves your problem.	3.	( )	( )

6. You have the problem of budgeting $700 for a quarter at Stanford. You know how much your room and board will cost, but beyond that you'll not be sure.

1. You'll try it for one quarter, keeping a record of costs and then apply the solution you've worked out to next quarter.

Y B
1. ( ) ( )

2. You'll go along as well as you can, if money runs out you can always get a loan or some help from your parents.

2. ( ) ( )

3. You'll try to think ahead, listing all probably costs such as laundry and entertainment and then portion your money accordingly.

3. ( ) ( )

7. You have the problem of arranging the furniture in your room. There is a chair, a desk, a bed, a bookcase, a bureau and a lamp. You want the desk under the window.

1. You place the furniture in several different locations, trying different patterns of arrangement until you find one you like.

Y B
1. ( ) ( )

2. You try to visualize the room, taking into account the size and location of the different pieces of furniture and work it out in your head.

2. ( ) ( )

3. You invite your house-mates in to get their suggestions, and utilize the best of these.

3. ( ) ( )

8. You know that an automobile dealer ordered 1,000 tires one day. This was enough for four tires for each car and two tires for each motorcycle he had on hand. Altogether he had 296 vehicles. You want to know how many cars and how many motorcycles he had.

1. You tried several combinations of numbers until you came up with 92 motorcycles and 204 cars.

Y B
1. ( ) ( )

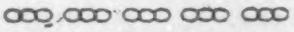
2. You realized you were dealing with a simple algebra problem and worked it out.

2. ( ) ( )

3. You asked the automobile dealer.

3. ( ) ( )

9. You have five pices of a necklace. Each piece is made up of three links. You want to join the five pieces into a single length of necklace. What is the smallest number of links that you must open and close to do this?



		Y	B
1. You ask a jeweler. He says 3 links.	1.	( )	( )
2. You try opening links until you can join all five pieces.	2.	( )	( )
3. You think the problem over until you realize that it can be done in 3.	3.	( )	( )

10. You are faced with the problem of how to study most effectively for a test so that you can get a good grade and retain the most material.

		Y	B
1. You consider all the factors, such as time, amount, and what is most interesting and then work out a plan.	1.	( )	( )
2. You get in a study group and work together with others on it.	2.	( )	( )
3. You systematically try different study systems, then choose the one that works best for you.	3.	( )	( )

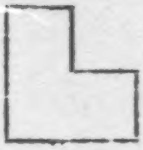
11. You are trying to lose 12 pounds so that you may try on a new suit. By careful dieting you lose 4 pounds each week. Each weekend, however, you gain back 3 pounds. How long will it be before you can try on the suit?

		Y	B
1. You try it, and find that it takes nine weeks.	1.	( )	( )
2. You think it over, realize that you can try on the suit at the end of the ninth week.	2.	( )	( )
3. You ask your dietician.	3.	( )	( )

12. You are trying to find a bleach that will make your hair just the color you want it.

		Y	B
1. You work out a formula in chemistry.	1.	( )	( )
2. You ask a druggist for his advice.	2.	( )	( )
3. You try different combinations on some cut hair.	3.	( )	( )

13. You are given the three-quarters of a square, the figure to the right. Draw lines to show how the figure could be divided into 4 parts which are equal in size and shape.



		Y	B
1. You draw several trial lines until you find out how.	1.	( )	( )
2. Ask someone who's good in geometry.	2.	( )	( )
3. Work it out in your head.	3.	( )	( )

14. You want to find out what is the best path to follow when making the turn at first base when running from home to second base.

		Y	B
1. Consult the coach.	1.	( )	( )
2. Try several methods of running.	2.	( )	( )
3. Consider all the factors, angles, running time, etc.	3.	( )	( )

15. You are making a skirt which is to be a full circle, and you have a square piece of cloth which is just large enough. You need to know how much material will be wasted.

		Y	B
1. You find the area of the circle and subtract it from the area of the square.	1.	( )	( )
2. You lay an old skirt over the material and measure the leftover material.	2.	( )	( )
3. You consult a friend who has had more sewing experience than you have.	3.	( )	( )

16. You are faced with the problem of building a floor over a slanting roof. You want the floor to be level, but the roof has a 20° slope.

		Y	B
1. You project the angle of the roof the length of the floor and then compute the size of the brace you will need.	1.	( )	( )
2. You hire a carpenter.	2.	( )	( )
3. You lay a board out level above the roof and then measure the brace.	3.	( )	( )

APPENDIX 5

REVISED PARALLED SETS OF MASCULINE AND FEMININE ROLE-APPROPRIATE PROBLEMS

This appendix contains only the problems which were revised or substituted for problems in the original sets. The original problems may be found in Appendix 3. F designates problems appropriate to the feminine role, while M designates problems appropriate to the masculine role.

F1 and M1 are identical with F11 and M11 in Appendix 3.

F2 - F7 and M2 - M7 are identical with the corresponding problems in Appendix 3.

F8. For a party, Carol wanted to cut several small birthday cakes into four pieces. Use straight lines to show how she could cut this cake into four pieces of the same size and shape, without drawing any of the lines through any of the candles (dots on the drawing).
(Figure is identical with the figure for F8 in Appendix 3.)

M8. As an engineering project, John had to divide a square into four parts. Use straight lines to show how he can divide this square into four parts of the same size and shape, without drawing any of the lines through any of the dots.
(Figure is identical with the figure for M8 in Appendix 3.

F9 - F10 and M9 - M10 are identical with the corresponding problems in Appendix 3.

F11 and M11 are identical with F1 and M1 in Appendix 3.

F12 - F13 and M12 - M13 are identical with the corresponding problems in Appendix 3.

F14 and M14 have problem statements identical with F14 and M14 in Appendix 3; however, the figures have been changed slightly, while maintaining the same principle.

F15. A bride's mother ordered 38 candles for her daughter's wedding. This was enough to provide four candles for each four-stem candlestick and two candles for each two-stem candlestick she had on hand. Altogether she had 12 candlesticks. How many two-stem candlesticks and how many four-stem candlesticks did she have?

M15. An automobile dealer ordered 38 tires one day. This was enough to provide four tires for each car and two tires for each motorcycle he had on hand. Altogether he had 12 vehicles. How many cars and how many motorcycles did he have?

F16 - F20 and M16 - M20 are identical with the corresponding problems in Appendix 3.